REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE
6/20/97

3. REPORT TYPE AND DATES COVERED
Final Technical 9/15/93 - 4/14/97

4. TITLE AND SUBTITLE
Millimeter Wave Source Using a Phase Matched Non-Linear Multiple Quantum Well Optical Guide

5. FUNDING NUMBERS
61103D
3484/TS

6. AUTHOR(S)
Kang L. Wang

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
University of California, Los Angeles
Department of Electrical Engineering
405 Hilgard Avenue
Los Angeles, CA 90095

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U. S. Air Force
Office of Scientific Research - NE
110 Dundan Avenue, Room B115
Bolling AFB, DC 20332-8080

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
F49620-93-1-0515

11. SUPPLEMENTARY NOTES
AASERT Program of AFOSR

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release. Distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This research has been aimed at investigating new means of microwave and millimeter wave generation using a nonlinear optical waveguide structure. Research has focused on the approach of using a single Ti-sapphire laser to produe separate beams which are shifted slightly in frequency by the use of very narrow bandpass filters.

19971003 059

14. SUBJECT TERMS
quantum wells, microwave, non-linear optics

15. NUMBER OF PAGES
2

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFED	UL

FINAL TECHNICAL REPORT
on
AASERT RESEARCH GRANT NO: F49620-93-1-0515
Millimeter Wave Source using a Phase Matched Non-Linear Multiple Quantum Well Optical Guide

by
Kang L. Wang, P.I.
Kevin W. Alt, Student
UCLA-EE Dept.

This research has been aimed at investigating new means of microwave and millimeter wave generation using a nonlinear optical waveguide structure. Since our last report, the research has been focused on the approach of using a single Ti-sapphire laser to produce separate beams which are shifted slightly in frequency by the use of very narrow bandpass filters. The Ti-sapphire laser produces extremely short pulses in the 200 fs range, which by Fourier transform have a fairly broad frequency spectrum. After passing the output beam through a beamsplitter, the beams were filtered to produce two signals with wavelengths approximately 10 nm apart. With a fundamental output signal at 900 nm, this produces a difference frequency signal of approximately 81 υm. The two beams were focussed into a waveguide structure which was polished and beveled at 45 degrees at the input edge in order to maximize the E-field components which are perpendicular to the quantum well structure. The optical pump wave was trapped within the channel by sandwiching the Quantum well structure between layers with lower indexes of refraction. In this manner, the pump waves travel the length of the waveguide structure with approximately 50 percent of the polarization in the proper orientation. The output wave is normal to the waveguide structure and cannot be confined by the small dimensions of the channel. In future work, the top and bottom structures of the sample could be optimized to form a cavity for the output wave to enhance the output coherence and minimize its divergence. The principal difficulty with this research has continued to be the lack of detectors in this frequency spectrum. Evidence of the output signal has been seen on the available instruments, but the data is thus far difficult to reproduce and analyze. In order to optimize the alignment of the input beams and to test other nonlinear properties of the quantum well structure, sum frequency generation was studied since this produces signals which are easily detectable by the available photodetectors and optics. Although there are some slight variations in the physics of the two different processes, a good portion of the work required to produce difference frequency signals had to be completed in order to produce sum frequency waves. The next step is to acquire an adequate detector and push into the millimeter regime. Currently, it is felt that a bolometer would be the best means of detecting these signals although recent advances in long wavelength photo detectors are encouraging for future research in the quasi-optical portion of the spectrum.

The student involved in this research is making satisfactory progress towards the completion of his Ph.D. It is expected that this student will complete his studies in early 1998. One previous student involved in the initial phases of this research completed his Ph.D. in 1996.